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IS 4225 (2004): Recommended Practice for Straight Beam Ultrasonic Testing of Steel Plates [MTD 21: Non-Destructive Testing]

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परीक्षण की अनुशंसित रीति
(दूसरा पुनरीक्षण)
Indian Standard
RECOMMENDED PRACTICE FOR STRAIGHT
BEAM ULTRASONIC TESTING OF
STEEL PLATES
(*Second Revision*)

ICS 77.040.20, 77.140.30

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Non-destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

Steel plates for use in boilers, pressure vessels and similar critical applications are ultrasonically tested to find out discontinuities such as pipes, ruptures laminations, etc. This standard was first published in 1967 and revised in 1979. This has now been revised on the basis of experience gained since its first revision and accepted current practice. More details regarding the test procedure, including the scanning technique have been incorporated in this revision.

Although the method recommended in this standard is generally applicable to all thickness, special accessories may be necessary for lower thicknesses wherein the depth occupied by the initial pulse is to be evaluated for defects.

This standard does not prescribe any acceptance criteria for plates, which should be as agreed to by the contracting parties. However, a general guideline for the acceptance is mentioned in this revision as Annex B for guidance only.

In the preparation of this standard, assistance has been derived from the following publications:

BS 5996 : 1980 'Method for ultrasonic testing and specifying quality grades of ferritic steel plates' issued by the British Standards Institution

ASTM A 435/ A 435 M-92 'Standard specification for straight beam ultrasonic examination of steel plates' issued by the American Society for Testing and Materials

ASTM A 578 M-96 'Standard specification for straight beam ultrasonic examination of plain and clad steel plates for special applications' issued by the American Society for Testing and Materials

AMS 2632 'Ultrasonic inspection — Products less than 0.5" (12.5 mm) thick' issued by Aerospace Material Specification

AMS 2630 A 'Ultrasonic inspection — Products over than 0.5" (12.5 mm) thick' issued by Aerospace Material Specification

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

RECOMMENDED PRACTICE FOR STRAIGHT BEAM ULTRASONIC TESTING OF STEEL PLATES

(Second Revision)

1 SCOPE

This standard prescribes the procedure for carrying out straight beam, pulse echo ultrasonic examination of rolled carbon and alloy steel plates.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
2417 : 2003	Glossary of terms relating to ultrasonic testing (<i>first revision</i>)
12666 : 1988	Methods for performance assessment of ultrasonic flaw detection equipment
13805 : 2004	General standard for qualification and certification for non-destructive testing personnel

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2417 shall apply.

4 EQUIPMENT

4.1 Ultrasonic Apparatus

The apparatus shall be of straight beam pulse-echo type, which shall provide vertical linearity within ± 5 percent upto at least 80 percent of full screen height and a horizontal linearity within ± 1 percent of the range. It shall be capable of producing, receiving and displaying high frequency electrical pulses at the required frequency and energy levels, with high degree of accuracy, sharpness, ultra high resolutions and stability. The equipment shall have a calibrated attenuator or gain control. It also should have the provision for double crystal (TR) probe operation. The equipment should also have the sufficient range capacity for the required testing purposes.

4.1.1 Calibration

The ultrasonic apparatus shall be adjusted and calibrated prior to inspection as described in IS 12666.

4.2 Probe

The probe shall be of straight beam type (single or TR) using size and frequency capable of detecting the reference reflector with a signal to noise ratio better than 12 dB.

4.2.1 Other probes may be used for evaluating or pin pointing the indications, if required.

5 TEST CONDITIONS

5.1 The test should be carried out in an area reasonably free from any vibrations that may interfere with proper functioning of the ultrasonic equipment.

5.2 The surface of the plate, under examination, shall be cleaned and smoothened sufficiently to carry out the inspection with reference to the reference reflector so that the transfer correction is reduced to minimum possible, local rough surfaces shall be conditioned grinding to ensure proper contact of the transducer to the plate surface.

5.2.1 Any specified identification marks which may be removed when grinding to achieve proper surface smoothness, should be restored after testing.

6 PERSONNEL REQUIREMENTS

Personnel performing ultrasonic testing, in accordance with this standard shall be suitably qualified (Level I, II or III) as per guidelines of IS 13805 and be familiar at least with the following:

- a) Ultrasonic terminology;
- b) Instrument calibration;
- c) Effect of transducer material, size, frequency and mode on test results;
- d) Effect of material structure on test results;
- e) Effect of non-linearity on test results;
- f) Effect of thickness and discontinuities on test results; and
- g) Effect of surface condition on test results.

7 TEST PROCEDURE

7.1 Ultrasonic examination should be carried out on either major surface of the plate by anyone of the following methods:

- a) Direct contact;
- b) Immersion; or
- c) Liquid column coupling.

7.1.1 If required by the purchaser due to higher width of transmitted pulse, the plate shall be inspected from the opposite side or by TR probe or high frequency highly damped probe. Plates ordered in the quenched and tempered condition shall be tested after heat treatment.

7.2 Couplant

The couplant used may be water, soluble oil, glycerine, light machine oil or greases. The coupling medium shall be non-corrosive and adequate precaution shall be taken to ensure that any coupling medium which may be deteriorous to the material or which may interfere with its subsequent processing is completely removed after completion of the test.

7.3 Test Frequency

The nominal test frequency shall be chosen taking into consideration of the material (grain size, microstructure, etc), thickness of the material and the minimum size of the flaw that is looking for, the extent of dead zone, noise level, etc. This optimum frequency shall be used for testing and evaluation.

7.4 Scanning

7.4.1 Reference Setting for Scanning

Back reflection method or reference reflector method shall be used depending on the purchaser requirement.

7.4.1.1 With reference to reference reflector

Scanning shall be carried out with an instrument adjustment which is 6 dB higher than the required reference sensitivity level. The reference level shall be set by adjusting the first reflection from the reference reflector at minimum metal distance up to at least 80 percent of the full screen height and noting down the subsequent first reflection from the remaining reference reflector metal distances. It should be noted that the reflection amplitude from the reference reflector at the maximum metal distance should be kept greater than 20 percent of full screen height. Sensitivity adjustments shall be made to accommodate for transfer correction from the reference block to the material under test.

Reference level can also be set by using DGS diagram or DGS scales for specific probes with proper attenuation and transfer correction if required. If attenuation and transfer corrections are required, they are to be carried out for proper evaluation of flaw size.

7.4.1.2 Wherever scanning is not called for with reference to a reference reflector then the general scanning can be carried out with an instrument adjustment that will produce a first reflection from the opposite side of a sound area of the plate at least 80 percent of the full screen height plus 6 dB. In this case minor sensitivity adjustments may be made to accommodate for surface roughness. Damping or reject control of the equipment should be kept minimum.

7.4.2 The extent of scanning shall be depending on the purchaser requirement. It can be either grid scanning or it can be 100 percent surface scanning.

7.4.3 When a discontinuity indication is observed during the general scanning, the instrument should be adjusted to produce back the reference setting with transfer correction. This setting shall be maintained during evaluation of the discontinuity indications.

8 RECORDING OF DISCONTINUITY INDICATIONS

8.1 All discontinuity indications, complete loss of back reflection and loss of 50 percent or more back reflection shall be recorded. The user may use the acceptance levels given in Annex A or specify as per requirement and manually acceptance to manufacturer.

8.2 When grid scanning is performed and discontinuity indications as in 8.1 are detected along a given grid line, the entire surface area of the squares adjacent to these indications shall be scanned. When loss of back reflections are indicated, the entire surface giving this loss of back reflection centered on these indications shall be scanned. The boundaries of these discontinuities shall be established by the technique given in 8.2.1.

8.2.1 The probe shall be moved away from the centre of the discontinuity until the height of the discontinuity indication becomes half of its original maximum value. The plate should be marked at a point equivalent to the centre of the probe. This operation should be repeated to establish the boundaries of the discontinuity. If the acceptance criteria mentioned in Annex A is followed, then the measurement of linear discontinuity may be carried out using a very small diameter probe for improving the accuracy of measurement.

9 ACCEPTANCE CRITERIA

Ultrasonic acceptance criteria for plates should be based on the design requirements of the product into which the plate is further processed or a realistic appraisal of the service requirements and the quality that may normally be obtained in the production of a particular type of plate.

10 RECORD OF TEST DATA

10.1 The following data should be recorded at the time of each test for future reference:

- a) Identification, material specification and size of the plate;
- b) Condition of the surface of the plate;
- c) Reference sensitivity;
- d) Make and model of the test unit;
- e) Amplification or gain control of the equipment;
- f) Description of the probe;
- g) Couplant used;
- h) Mode of scanning;

- j) Ultrasonic indications and description of discontinuity; and
- k) UT operator's name, his level and date of test.

10.2 The test report should be prepared containing the following information:

- a) Date of testing;
- b) Reference number of the plate;
- c) Amplitude of the defect indications, reduction in back echo amplitude, depth of the defect and location of the defect; with respect to point; and
- d) Sketch showing the location of the flaw indications on the scanning surface.

ANNEX A

(Clauses 8.1 and 8.2.1)

ACCEPTANCE CLASSES FOR STRAIGHT BEAM TESTING

<i>Quality</i>	<i>Single Discontinuity FBH Size</i>	<i>Multiple Discontinuities FBH Size</i>	<i>Linear Discontinuity, Max</i>	<i>Loss of Back Reflection Percent, Max</i>
(1)	(2)	(3)	(4)	(5)
AA	1.2	0.4	0.4 FBH response for 3 mm	<i>See 8.1</i>
A1	1.2	0.8	0.8 FBH response for 6.4 mm	<i>See 8.1</i>
A	2.0	1.2	1.2 FBH response for 12.7 mm	<i>See 8.1</i>
B	3.2	2.0	2.0 FBH response for 25.4 mm	<i>See 8.1</i>
C	As established by the purchaser and the vendor for specific part and use			

NOTE — Diameter of flat bottom hole in millimetres.

ANNEX B
(Foreword)
DETERMINATION OF THE TYPE OF DEFECT

B-1 The first step in any detailed plate examination is determination of the type, approximate size and nature of the defect since this affects the beam form and equipment response.

B-2 The amount of probe movement, behaviour of the defect signal and back echo clearly indicate the type of defect when used in conjunction with other factors.

B-3 When making an assessment it is essential to consider the back echo pattern rather than the effect on the first back echo in isolation. The information given in Table 1 may be used as a guide in this assessment, but should not be regarded as a substitute for ultrasonic skill and knowledge.

Table 1 Guide to Defect Assessment
(Clause B-3)

Sl No.	Defect Echo Type (1) (2)	Effect on Back Echo on Transmission (3)	Assessment (4)
i)	Large discrete, persisting with probe movement. No substantial movement of echo on time base	Zero at all test frequencies	Lamination exceeding probe
ii)	Small to medium, persisting with probe movement. Some movement of echo on time base. More than one echo interconnected	Attenuated or zero at all frequencies	Irregular cavity defect with planes inclined to plate surface. Present only in plate with low reduction
iii)	Medium to large, discrete not persisting with probe movement	Attenuated, recovering with probe movement	Isolated laminations of width less than beam width
iv)	Small to large, fluctuating with probe movement. No substantial movement of echo on time base	Fluctuating with probe	Region of imperfection containing small laminar defects
v)	Many small echoes fluctuating and extending in depth through the plate	Considerable attenuation depending on frequency	Distributed small defects Inclusion clusters. Dirty plate

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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